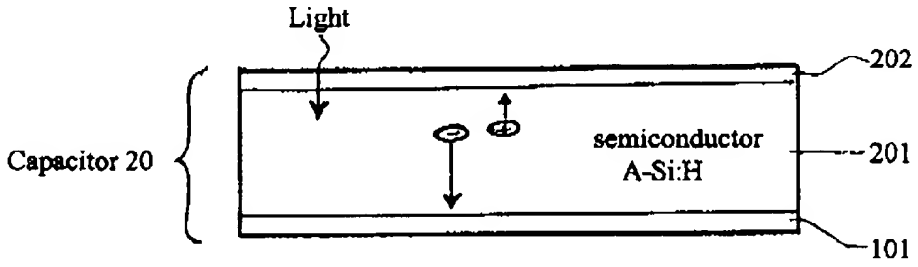
Appl. No. 09/334,671
Response dated October 15, 2003
Reply to Office Action of Sept. 5, 2003

REMARKS/ARGUMENTS

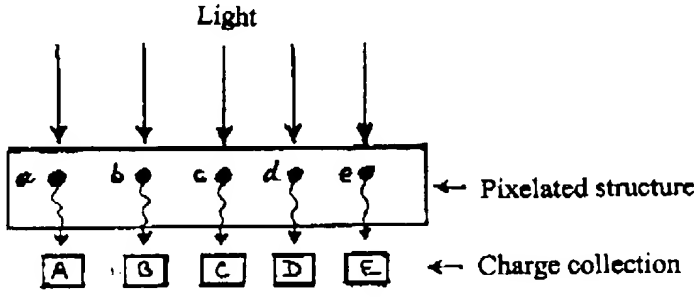
Claims Rejections - 35 USC § 103

The basic reference on which the Examiner relied to reject claim 1 is Morton U.S. Patent No. 5,693,947 which discloses a fairly standard indirect x-ray image detector for radiology.

Morton's structure of the intrinsic a-Si:H layer 201 which the Examiner compared to applicants' coplanar thin layer of amorphous selenium based multilayer structure can be illustrated as follows (see Figs. 6 & 7 of Morton):



As clearly shown in the above structure, the semiconductor 201 is the dielectric of the capacitor 20 as well as its photodetector. The drift current in such semiconductor depends on the field P_m, as disclosed in column 7, lines 59-65. The charge is then collected on charge collection electrodes 101 and stored in this capacitor 20, as is the information. Such detectors are of necessity pixelated since the flow of the charges comes from pixelation as illustrated below.



Thus, in Morton the physical separation of the charges comes from pixelation.

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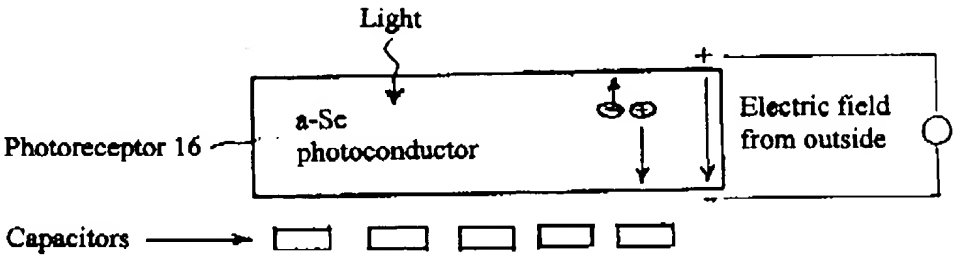
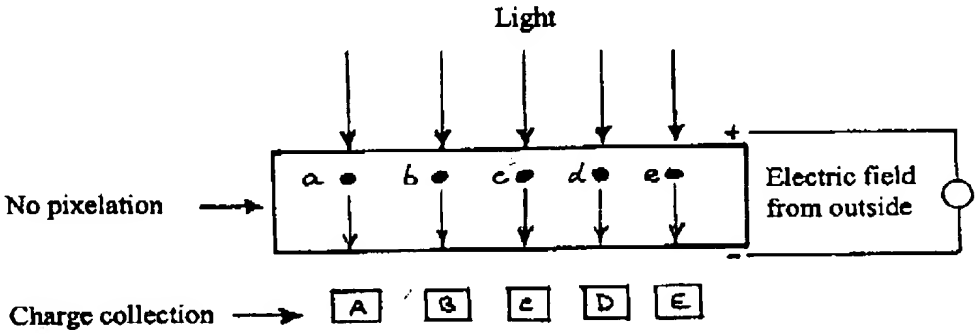
In contrast, the applicants' structure can be illustrated as follows:



In applicants' case, the photoreceptor 16 made of co-planar thin layer of amorphous selenium based multilayer structure acts as a photoconductor (and not as a semiconductor of Morton). It is the effect of an electric field applied from the outside that drives the charges to the underlying capacitors which store the information (see last line of page 6 and first line of page 7 of the disclosure). The flow of charges can be represented as follows:



Thus, in applicants' case, it is the effect of the electric field that provides the position of the charges and not pixelation which is thus not required.

In summary, in Morton the layer a-Si:H is a true semiconductor and acts as a dielectric of the capacitor and requires pixelation. In applicants' indirect x-ray image detector, the co-planar thin layer of amorphous selenium based multilayer structure acts as photoconductor and is not associated with the operation of the capacitors. It is an electric field applied from the outside that drives and directs the charges in the thin amorphous selenium layer without any need of pixelation.

The basic feature of applicants' invention is, therefore, the unexpected finding that a thin layer of a-Se photoconductor, which until now has been used in direct digital radiographic

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systems in the form of a thick layer, can be used in the indirect x-ray image detector.

Generally, it is well known by those skilled in the art that there is a clear distinction between direct and indirect digital radiographic systems. The main difference between the two types of detectors is in the conversion process. For direct detectors, a thick photoconductive layer of amorphous selenium (a-Se) is used. The layer converts the x-ray energy to an electronic charge that is directed to the collecting pixel capacitors by an electric field. For indirect detectors, a phosphor layer is used which converts the energy of x-ray photons to visible light photons that are subsequently detected by pixel photodiodes (semiconductors) and stored in the form of electronic charge in the collecting pixel capacitors. The phosphor layer may be made from phosphor materials with an oriented structure, such as cesium iodide (CsI).

This difference is explained in the Schiebel et al. U.S. Patent No. 5,396,072 (also cited by the Examiner as a secondary reference). In column 3, lines 6 to 9, Schiebel states: "Image detectors for visible light (indirect) are distinct from X-ray image detectors (direct) in that they comprise only a thin semiconductor layer instead of a comparatively thick photoconductor layer."

Consequently, a finding by the present applicants that the use of co-planar thin layer of amorphous selenium based multilayer structure as a photoreceptor (and photoconductor) for an indirect x-ray image detector represents a highly unobvious concept for one skilled in the art.

In contrast, the Morton patent clearly relates to the standard indirect system which uses a pixel semiconductor photodiode structure as a conversion system.

The combination of Morton with Perez-Mendez does not add anything to modify this basic system. It mentions a photodiode 57 of a p-i-n type where the lower layer 60 is formed of a-Si:H but it is stated that it could also be formed of amorphous selenium, antimony triselenide, cadmium sulphide, etc. It is still a semiconductor or photodiode structure clearly requiring pixelation and there is absolutely no indication that it could act as a photoconductor without pixelation. By the way, in applicants' p-i-n structure the thin amorphous selenium layer is not the lower "n" layer but rather the "i" layer which is sandwiched between the two other layers (page 9, lines 23-24). Thus, even in this aspect there is a clear difference.

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Finally, with regard to the Schiebel reference, it discloses a conventional direct x-ray image detector which uses as photoreceptor a thick layer (200-800μm) of amorphous selenium based multilayer structure (column 5, lines 38-40). There is no suggestion either in Schiebel or, to applicants' knowledge, anywhere else in the prior art that a photoconductor used in a direct x-ray image detector could also be used in an indirect x-ray image detector, but after being modified from a thick a-Se multilayer structure to a thin a-Se multilayer structure. It is submitted that this is a totally novel and unexpected development that fully deserves patent protection.

We believe that the Examiner essentially agreed with out explanation during our conference of October 9, 2003, however, if he has further questions or suggestions, we ask the Examiner to call the undersigned patent agent to discuss the same.

Concerning the Examiner's statement that in claim 1 it is not indicated that the co-planar thin layer of amorphous selenium based multilayer structure is not pixelated, it is respectfully submitted that this would be well understood by fairly reading the claim and the disclosure. Usually, the negative definitions such as "non-pixelated" or "not pixelated" are not used in the claims. In fact, they may imply that the layer was or should have been pixelated, but became non-pixelated, which is not the case herein. The applicants have used the positive word "co-planar" to indicate that it is a non-pixelated layer. The Miriam Webster's Collegiate Dictionary (Tenth Edition) defines "co-planar" as lying or acting in the same plane. By this, the applicants wanted to indicate that the thin layer of a-Se based structure was lying and acting as a layer covering the entire image plane, rather than being broken-up into an array of pixelated layers. The term "co-planar" is not used in the cited prior art to indicate a different meaning and therefore by referring to the text of the application, this meaning is clearly evident. Another word is also used by the applicants in the text, namely "uniform" (page 1, lines 10 and page 4, line 2). If the Examiner believes that it would be a better word to define this "non-pixelated" feature, he is authorized to replace the word "co-planar" by "uniform" or to add the word "uniform" after "co-planar" in claim 1. Generally, however, if a layer is pixelated, it must be positively identified as such in the claim. On the other hand, if it is not pixelated, it is believed that one does not need to specify the lack of something (i.e. pixelation) in the claim.

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In view of the above remarks, it is believed that claim 1 should be found allowable, and since all the other claims are dependent directly or indirectly on claim 1, they should also be found allowable.

Respectfully submitted,

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